PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B27K 5/06, 5/00

A1

(11) International Publication Number: WO 93/19910

(43) International Publication Date: 14 October 1993 (14.10.93)

(21) International Application Number: PCT/GB93/00696

(22) International Filing Date: 2 April 1993 (02.04.93)

(30) Priority data:

9207418.6	4 April 1992 (04.04.92)	GB
9306627.2	30 March 1993 (30.03.93)	GB

(71) Applicant *(for all designated States except US)*: WOODFORM DESIGN UK LIMITED [GB/GB]; 11 King Street, King's Lynn, Norfolk PE30 1ET (GB).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)* : PRATT, David, Piers, Ross [NZ/NZ]; Matatea Road, RD1, Waimauku, Auckland (NZ). PRATT, Richard, Gordon, Warren [NZ/NZ]; Heald Road, RD1, Papakura, Auckland (NZ).

(74) Agent: HOOPER, John, Peter, Lindesay; 5 Haslingfield Road, Harlton, Cambridge CB3 7ER (GB).

(81) Designated States: AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, KZ, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published
With international search report.

(54) Title: BENDING AND SHAPING MDF

(57) Abstract

MDF, or medium density fibreboard, is a common replacement for wood. It is usually manufactured as flat sheets, and is a stiff, rigid, inflexible material that is difficult to bend into the sort of complex shapes often required. It has now been found that by impregnating MDF with ammonia (used in anhydrous - that is to say, dry gaseous - form) the MDF can be made relatively plastic, and in its plasticised state can quite easily be pressed or bent into almost any shape required.

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NL	Netherlands
BE	Belgium	GN	Guinea	NO	Norway
BF	Burkina Faso	GR	Greece	NZ	New Zealand
BG	Bulgaria	HU	Hungary	PL	Poland
BJ	Benin	IE	Ireland	PT	Portugal
BR	Brazil	IT	Italy	RO	Romania
CA	Canada	JP	Japan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo			SE	Sweden
CH	Switzerland	KR	Republic of Korea	SK	Slovak Republic
CI	Côte d'Ivoire	KZ	Kazakhstan	SN	Senegal
CM	Cameroon	LI	Liechtenstein	SU	Soviet Union
CS	Czechoslovakia	LK	Sri Lanka	TD	Chad
CZ	Czech Republic	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	UA	Ukraine
DK	Denmark	MG	Madagascar	US	United States of America
ES	Spain	ML	Mali	VN	Viet Nam
FI	Finland	MN	Mongolia		

Bending and shaping MDF

This invention relates to bending and shaping MDF (medium density fibreboard).

Wood is an expensive and rather intractable medium for the construction of articles, and for many years various man-made composites have been used instead, sometimes because of cost and sometimes because of the achievable properties. One such material is that known as MDF, or medium density fibreboard, which has been available since the early 1970s. MDF is basically wood fibres compounded together with amounts of one or more synthetic resin, often one based upon formaldehyde (usually a urea-formaldehyde resin, and sometimes advantageously a melamine-urea-formaldehyde [this type of MDF is often known as MUF, or HMR, the latter standing for high moisture resistance], and typical such materials available under the generic name MDF are those sold by Medite, Caberboard and Silverpan, the exact details of which are not generally known. The main present uses for MDF are in the manufacture of furniture and kitchen and bathroom fittings (cupboards and shelves, and so on).

MDF is commonly manufactured as flat sheets or boards of various thicknesses (typically from 3 mm to 25 mm) and densities, and may be supplied with a visually-attractive paper- or wood-veneer or plastics surface coating. It is a stiff, very rigid, practically inflexible material, with almost no plasticity, and unless it is provided as very thin sheets, with some limited degree of flexibility by virtue of that very

thinness, it is difficult if not impossible to bend or otherwise form into the sort of complex shapes often required.

It has now been found that by impregnating MDF with ammonia (used in anhydrous - that is to say, dry gaseous - form) the MDF can be made relatively plastic, and in its plasticised state can quite easily be pressed or bent into almost any shape required.

In one aspect, therefore, the invention provides a method of shaping MDF in sheet form, in which the MDF is treated with ammonia so as to impregnate it therewith, causing it to become relatively plastic, the thus-plasticised MDF is then shaped as desired, and the ammonia is then allowed to dissipate, whereupon the MDF reverts to its normal, relatively unplastic, form, which it thereafter maintains.

The MDF may be any of those materials commonly known as MDF, including especially that known as MUF.

The MDF sheet shaped by the process of the invention may intrinsically be of any appropriate shape, size and thickness. As noted above, typical thicknesses for MDF range from 3 to 25 mm, and the method of the invention can successfully be applied to any of these. Moreover, perhaps slightly surprisingly the MDF sheet may already have a previously indented surface, giving it in section a shaped profile, and this will be substantially undistorted even when the sheet has thereafter been bent and shaped by the method of the invention.

In the process of the invention the MDF is treated - conveniently at room temperature (around 15°C) - with

gaseous ammonia so as to impregnate it therewith, causing it to become relatively plastic. The ammonia reacts with the MDF, and with the moisture in the MDF, in an exothermic reaction the heat from which raises the MDF's temperature 5 or 10°C. It is believed that the reaction of the ammonia enables the cellulose molecules making the wood, as well as the wood fibres made therefrom, to release their grip one on another and on the bonding agent (typically a urea-formaldehyde resin), and so separate to allow them to be re-positioned as required while any applied bending or impressing occurs. In other words, the altered chemical (and physical) nature of the MDF, coupled with the rise in temperature, causes the MDF to become rather more plastic - that is, able to have its shape changed by an applied force without immediately recovering its original shape when that force is removed - than in its original state. Of course, once the ammonia has been removed, or dissipates, the molecules/fibres re-bond in their new positions, without any distortion of the MDF.

The ammonia, which is preferably in dry (anhydrous) gaseous form, may be applied to the MDF in a variety of ambient physical circumstances. For example, it may be applied in a sealed pressure chamber (which may take the form of a standard autoclave, but can also be nothing more complicated than a sealed plastic bag [albeit one capable of withstanding the pressures and temperatures involved] under a slight pressure of up to 4 Bar (about 4 atmospheres). However, the higher the pressure the more likely the ammonia will be absorbed into the MDF, reacting with it and the moisture therein, so quickly and in such amounts that localised overheating occurs to cause swelling and bubbles in the MDF as it expands, distorting the MDF and even leading to surface unevenness and possibly explosive disintegration of the

MDF. Most preferably, therefore, the applied pressure is kept low, and is about 1 Bar (1 atmosphere).

It may be advantageous to evacuate the pressure chamber containing the MDF prior to feeding in the ammonia, for by doing so the applied pressure of the ammonia can be kept low and yet the treatment period can be reduced (but without fear of distorting the MDF as mentioned above).

The rate at which the treatment ammonia is absorbed into the MDF depends to some extent upon the moisture in the MDF, the rate being higher the wetter it is. Accordingly, ensuring that the MDF is moist will result in a shortening of the time of treatment - but as observed elsewhere too rapid an impregnation can cause surface blemishes and deformation, and care should be exercised when speeding treatment up in this way.

The period during which the MDF is so treated will also depend to some extent upon the density and thickness of the MDF, and upon the temperature. The higher the density and thickness the longer a treatment is required, while the higher the temperature the shorter the treatment needed. Thus, for example, a 6 mm sheet can successfully be treated for a period of 1 hour and a temperature of 15°C, while a 16 mm sheet might need a longer and/or hooter treatment - maybe for 3 hours and/or at 20°C.

Once impregnated with ammonia the MDF becomes relatively plastic, and the thus-plasticised MDF is then shaped as desired. The shaping may be done in any convenient manner, and may cause the MDF to have any suitable form. Typically, a sheet (or part thereof) of MDF can be stamped or impressed with surface patterns so

that it looks embossed, while a strip of MDF can be clamped to and bent round a former into a curve.

Although the plasticised MDF sheet may be bent and shaped entirely by hand, one suitable bending and shaping method involves the use of a jig - that is, a pre-shaped surface or set of points around which the MDF sheet can be bent and clamped into place while it "sets". The art of jig construction and use is in general well-known, and no more need be said about it here.

If the bending or shaping is to involve a stamping or pressing operation, then this can be accomplished in any convenient way - in a conventional press, or using rotating rollers, for instance. This type of shaping method is in general well-known, and needs no further comment here.

The degree of bending attainable without damaging the MDF depends to some considerable extent of the thickness of the MDF, thin sheets being understandably more bendable than thick ones. In tests using the method of the invention it has been possible reliably to bend sheets as follows to make commercially-useful products:-

Sheet Thickness (mm)	Normal Bend outside diameter (mm)	Extreme Bend outside diameter (mm)
18.7	300	155
16	230	120
12	190	90
6	50	40

Once the plasticised MDF has been shaped as desired, the ammonia is then allowed to dissipate, whereupon the MDF reverts to its normal, relatively

unplastic, form, which it thereafter maintains. For example, a strip of MDF clamped to and bent around a former in a jig may simply be left there for several hours, during which the ammonia diffuses out of the strip and away, and when removed from the former the strip will then hold its new shape. However, it may be desirable to accelerate this "drying", setting, stage, and various techniques can be employed, including the application of heat (as by radiant heat, or even radio frequency induction, as in a microwave oven) and/or vacuum, and the passing of air currents across the surface (hot air heats, while moist air extracts chemically). It may be desirable, in order to improve the drying effect, if possible to release those parts of any jig (or other former device) that would otherwise occlude one or more of the sheet;s surfaces.

The surface of an MDF sheet treated by the method of the invention may be roughened slightly as a result of moisture absorption. This roughening can usually be removed by a simple buffing operation once the bent and shaped sheet has been dried and thus "fixed" into the required shape.

Although the ammonia treatment of the method of the invention may cause a small amount of swelling of the MDF sheet, this is not significant, and should not cause any noticeable distortion of the finished product.

The invention extends, of course, to shaped MDF articles whenever made by a process according to the invention.

The following Examples are now given, though by way of illustration only, to show details of an embodiment of the method of the invention.

Example 1: Bending and shaping of MDF

Stage 1: Plasticisation of the MDF

Using a purpose-built circular-section autoclave of dimensions 4.2 m by 250 mm internal diameter, there were plasticised a dozen strip-like sheets of MDF each of dimensions 150 mm by 18.7 mm and various lengths from 1.5 m to 3.6 mm. This MDF was obtained from Nelson Pine Industries, of Auckland, under the name THINLINE (this is an MUF material).

First, the sheets were placed in the autoclave, and the latter was evacuated down to a pressure of 0.1 Bar and stabilised at ambient temperature. The sheets were held at this low pressure for 2 mins, whereupon gaseous ammonia (from a cylinder of anhydrous liquid ammonia) was allowed in over a period of 4 mins, all the while maintaining the temperature more or less constant, until the internal pressure had risen to 4 Bar.

Once all the ammonia had been introduced, the sheet was kept in the ammonia atmosphere for 4½ hours at the same temperature and pressure. During this time the chemical action of the ammonia caused the binding forces between the MDF constituents to become less, so that the MDF itself became plastic.

Stage 2: Bending the MDF

At the end of the specified time the ammonia remaining free in the autoclave was drawn off for disposal, the pressures were equalised, and the

autoclave was opened to allow the plasticised MDF sheet to be removed.

The sheets were taken out and placed in a variety of bending jigs of standard form as appropriate. In this way one, for example, was bent into a semicircle outside diameter 800 mm. Thus bent, the sheets were then secured in place in the jigs and allowed to "dry" - that is, the absorbed ammonia was allowed to evaporate off (this evaporation was encouraged by blowing warm air over the sheet). For the first half-an-hour or so each sheet was retained clamped in its jig, but at the end of this time it sheet was unclamped and removed from the jig, and allowed to dry "free-standing" for another four or five hours.

At the end of this drying stage each sheet had recovered its normal physical properties, but retained its new shape and resisted any ordinary attempts to unshape it.

Example 2: More bending and shaping MDF

Two further batches of MDF (this time the non-MUF material MEDITE, available from Medite Ltd) were bent and shaped in much the same overall manner, but with the following significant differences:-

a) The container used was a large heavy-duty plastic bag.

b) No initial vacuum was applied to one batch, while a 0.1 Bar vacuum was applied to the other.

c) The pressure of ammonia in the container was no more than 1 Bar.

d) For the pre-evacuated batch the treatment time was hour, while for the other it was 1½ hour.

e) Drying was effected under ambient conditions for 24 hours.

A third batch was treated in much the same way except that it was subjected to a 0.1 bar vacuum after the ammonia withdrawal to hasten the "drying" stage - and in fact the product needed no further drying at all.

The shaped MDF products made in these ways were all quite satisfactory.

CLAIMS

1. A method of shaping medium density fibreboard (MDF) in sheet form, in which the MDF is treated with ammonia so as to impregnate the MDF therewith, causing it to become relatively plastic, the thus-plasticised MDF is then shaped as desired, and the ammonia is then allowed to dissipate, whereupon the MDF reverts to its normal, relatively unplastic, form, which it thereafter maintains.

2. A method as claimed in Claim 1 applied to that form of MDF known as MUF (melamine-urea-formaldehyde).

3. A method as claimed in either of the preceding Claims, in which the MDF is treated with dry gaseous ammonia.

4. A method as claimed in any of the preceding Claims, in which the ammonia treatment is effected at ambient temperature.

5. A method as claimed in any of the preceding Claims, in which the ammonia is applied to the MDF in a sealed chamber.

6. A method as claimed in any of the preceding Claims, in which the ammonia treatment is effected at a pressure of from 1 to 4 bar.

7. A method as claimed in any of the preceding Claims, in which prior to the ammonia treatment the MDF is subjected to a reduced pressure.

8. A method as claimed in any of the preceding Claims, in which the ammonia-plasticised MDF is thereafter shaped using a jig.

9. A method as claimed in any of the preceding Claims, in which, once the plasticised MDF has been shaped as desired, the ammonia is then encouraged to dissipate by the application of heat.

10. A method as claimed in any of the preceding Claims and substantially as described hereinbefore.

11. A shaped MDF article whenever made by a method as claimed in any of the preceding Claims.

International Application No PCT/GB 93/00696

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B27K5/06; B27K5/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B27K

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	EP,A,0 197 674 (P.FAVOT) 15 October 1986 see page 3, line 19 - line 31 see claims	1-11
X	US,A,3 282 313 (C.SCHUERCH) 1 November 1966 see the whole document	1-11
X	AT,A,326 339 (INSTITUT KHIMII DREVESINY AKADEMI NAUK LATVIISKOI SSR IN RIGA) 10 December 1975 see page 3; example 2	1-11
X	US,A,3 642 042 (R.W.DAVIDSON) 15 February 1972 see the whole document	1-11

-/--

° Special categories of cited documents : [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

2

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
21 JUNE 1993	- 5. 07. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	DALKAFOUKI A.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X	CHEMICAL ABSTRACTS, vol. 73 Columbus, Ohio, US; abstract no. 16501, SKRUPSKIS, V. ET AL. 'Slide bearings from curved pieces of chemically plasticized' see abstract & LATV. LAUKSAIMN. AKAD. RAKSTI, VOLUME DATE 1968, NO. 23, 298-305 1969, ---	1-11
A	EP,A,0 320 712 (K.HELD) -----	

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9300696
SA 73096

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information. 21/06/93

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0197674	15-10-86	CA-A- 1236255	10-05-88
US-A-3282313		None	
AT-A-326339	10-12-75	None	
US-A-3642042	15-02-72	None	
EP-A-0320712	21-06-89	DE-A- 3742652	13-07-89
		JP-A- 1196304	08-08-89
		US-A- 4988478	29-01-91
		US-A- 5125812	30-06-92

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82